2.—An Ordovician Cystoid (Pelmatozoa, Echinodermata) from Western Australia

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Manuscript received.—18th June, 1963

The paper describes a new species of *Cheirocrinus* Eichwald from the Ordovician of the Kimberley Division, Western Australia. This is the first cystoid (Pelmatozoa, Echinodermata) to be described from Australia, and the first record of this genus from the Southern Hemisphere.

Introduction

There are comparatively few records of recognizable fossil Pelmatozoa (Echinodermata) in Australia, although "crinoidal" limestones are relatively common within the Palaeozoic sequence. This is the first description of a cystoid; a few blastoids have been described from the Upper Palaeozoic or eastern Australia (Brown 1941), and a limited number of crinoids are recorded from the Middle and Upper Palaeozoic of both eastern and western Australia.

Nevertheless some rare and interesting echinoderms have been found in Australia and undoubtedly many await discovery. Whitehouse (1941), described echinoderms from the Middle Cambrian or Thorntonia Station in north-western Queensland (lat 19°30′S., long. 138°55′E.) which were so unlike any previously known forms that he placed them in two new classes of a new sub-phylum—Haplozoa. They were associated with remains of cystoids, including "*Eocystis* (?)", which have not yet been described.

More recently Gill and Caster (1960) have described Silurian and Devonian carpoid echinoderms from Victoria, which are associated with "many other echinoderms—cystoids, blastoids, crinoids, machaerideans, starfish, and brittle stars".

The present paper records the occurrence of a new species of *Cheirocrinus* from the Ordovician of Western Australia. It is of considerable geological interest, even though at present it is represented by only one incomplete specimen, collected by Mr. D. Merrilees of the Western Australian Museum, Perth, Western Australia. It comes from the type-locality of the Emanuel Formation (Ordovician) in Emanuel Creek, lat. 18°39′S., long. 125°53′E. The approximate position is indicated in Figure 1, and is shown more accurately on the geological map by Guppy *et al.* (1958).

The discovery of a sequence of fossiliferous Ordovician rocks outcropping in the vicinity of Prices Creek over an area of about twelve square miles was first announced by Guppy and Öpik (1950) who described briefly the stratigraphy, structure and palaeontology of the sequence they named the Prices Creek Group. The occurrence was discussed later by Guppy *et al.* (1958) and by McWhae *et al.* (1958, pp. 28-29).

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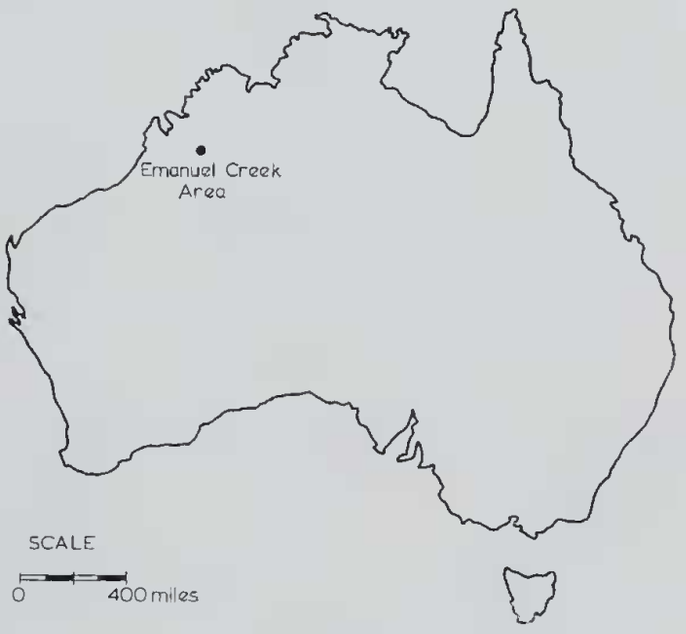

Fig. 1.

The Prices Creek Group consists of the (lower) Emanuel Formation and the (upper) Gap Creek Formation. A rich fauna obtained from both formations includes brachiopods, trilobites, gastropods and nautiloids which Guppy and Öpik recognised as ranging in age from Upper Ozarkian to Lower Trenton (Lower to Middle Ordovician) of the United States succession. The nautiloids have been described by Teichert and Glenister (1954). Earlier, Miss K. L. Prendergast (1935) had described a plectambonoid brachiopod, *Spanodonta hoskingae*, from beds now known as the Gap Creek Formation, which she mistakenly believed to come from the overlying Devonian. This brachiopod was recognised by Dr. G. A. Cooper of the U.S. National Museum, Washington, D.C. in 1946 (or earlier) as an Ordovician form (Browne 1952), but no details of its field-occurrence were known at the time.

The presence of *Cheirocrinus* in the Emanuel Formation confirms the previous evidence of the age of the formation, since the genus is known only from the Chazyan and Mohawkian (Trenton) of North America and from equivalent Lower and Middle Ordovician formations of Russia, Norway, Esthonia, Sweden, France, Portugal and Scotland. It has not hitherto been recorded from the Southern Hemisphere. (*See* Bassler & Moodey 1943). Unfortunately it is not known from which particular bed in the Emanuel Formation the specimen was derived.

I wish to thank Mr D. Merrilees for permission to examine this specimen.

Systematic Description

Phylum	ECHINODERMATA
Sub-Phylum	PELMATOZOA
Class	Cystoidea von Buch, 1844
Order	Rhombifera Zittel, 1879
Super-family	Glyptocystitida Bather, 1913
Family	Cheirocrinidae Jaekel, 1899

Bather (*in* Lankester 1900, p. 58) used the old family name "Glyptocystidae" to include the genera *Glyptocystis*, *Cheirocrinus*, etc. In his independent work, which was in the press at the same time as Bather's, Jaekel (1899) proposed the family name "Chirocrinidae". Bather (1913) in his work on Girvan cystoids accepted this classification, but emended the name to Cheirocrinidae to agree with the spelling of *Cheirocrinus* Eichwald, 1856, with the explanation (p. 434)—"The name Cheirocrinidae has now been chosen instead of the old-established 'Glyptocystidae', so as to avoid confusion with other senses of the latter name, and in particular to render it possible for anyone to follow Prof. Jaekel in transferring *'Glyptocystis'* to the Callocystidae without having to alter any Family name". Bather (1913, p. 363) used "Glyptocystidae" as the name of a super-family, and this was modified to "Glyptocystitida" by Regnell (1945).

The family name Cheirocrinidae has been accepted by Bassler and Moodey (1943, p. 5) and by Bassler (1943, p. 669) and Regnell (1951).

The arrangement and orientation of the plates of the theca and the position of the pore-rhombs in this family have been the subjects of investigation by a number of writers. Bather (1900, p. 58) published a figure (reproduced in Fig. 2) showing the actual distribution of the pore-rhombs in all known members of the family, numbering the thecal plates which occur in five cycles, in the order 1 to 24 as shown in Figure 2, a scheme which he used again in his study of the Girvan fauna (Bather 1913).

Foerste (1920, p. 41), Bassler (1943), Sinclair (1948) and others have followed this scheme of nomenclature, although Regnell (1951) has preferred Jaekel's (1899) system of numbering the plates as basals, 1-4; infra-laterals, 1-5; laterals, 1-5; etc.

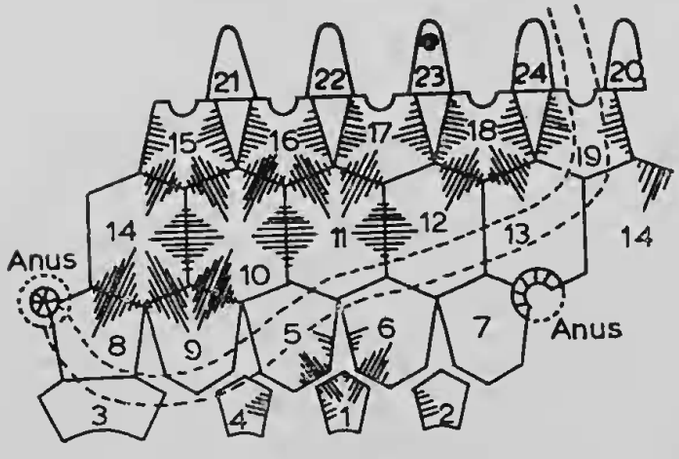

Fig. 2.—Diagrammatic sketch to show the actual distribution of the pore-rhombs in the Family Cheirocrinidae. (From Bather *in* Lankester 1900, p. 58, Fig. XX).

To avoid ambiguity for the Western Australian specimen and for easy comparison with similar specimens Bather's system is used in this paper.

Genus **Cheirocrinus** Eichwald, 1856

Eichwald, E., 1856. Bull. Soc. Nat. Moscou 29 (1): 123. For Synonymy *See* Bassler and Moodey (1943, p. 142). Type-species: *Cyathocrinus penniger* Eichwald, 1842.

Eichwald's original definition (1856) is as follows:—"Diese Gattung zeichnet sich durch strahlig gerippte Schilder aus, die parallel den Rippen eine Reihe durch-gebrochner länglicher Poren für die Sauger zeigen und auf den Schulterschildern kurze gegliederte Hände tragen, fast wie der *Ichthyocrinus* Hall aus Nordamerika: der Kelch ist gestielt und die grossen *Cornuliten* scheinen zu ihm oder zum *Echinoencrinus gigan-teus* zu gehören, mit dem überhaupt diese Gattung viele Verwandtschaft zeigt".

The type-species, *Cheirocrinus penniger*, is known to occur in Russia and Esthonia. It has been studied by various workers including Kirk (1911), and Bather (1913, p. 436, Text-figure 41) who has given an analysis of the plates showing the positions of the pore-rhombs and the shapes of the individual plates as determined from the diagrams of Jaekel (1899).

Bassler and Moodey (1943, pp. 142-144) have recorded no less than 24 species now assigned to this genus and additional species have been described by Bassler (1943) and Regnell (1951). I have been unable to consult the monograph on *Cheirocrinus* foreshadowed by Sinclair (1948), but a study of the literature shows there is great variation in the characters of the thecae of these species and it seems probable that in future several distinct genera may be recognised. The Western Australian specimen falls within the range of the genus *Cheirocrinus* as understood at the present time.

Cheirocrinus merrileesi, sp. nov.

(Fig. 3 (A, B, C), 4 and 5)

Holotype.—Western Australian Museum, Perth, Western Australia. Specimen No. 60.167.

Locality.—Emanuel Creek, Kimberley Division, 180 miles east-south-east of Derby, Western Australia.

Formation.—Emanuel Formation, Prices Creek Group. Ordovician. Collected by Mr D. Merrilees (22.VII.1960) on an expedition to the Fitzroy Trough. (*See* McKenzie 1961).

The specimen consists of the lower portion of a laterally compressed theca, of which twelve plates are preserved, comprising four infrabasals, five basals and three lateral plates, together with a few scattered anal plates and possibly portion of an ambulacrum adhering to one of the basal plates; the radiolateral and deltoid plates are missing and the column and brachioles are not preserved.

The specimen now measures about 18 mm in width, 6 mm to 7 mm in thickness and 21 mm in height. The complete thecal height was probably about 30 mm and the true width and

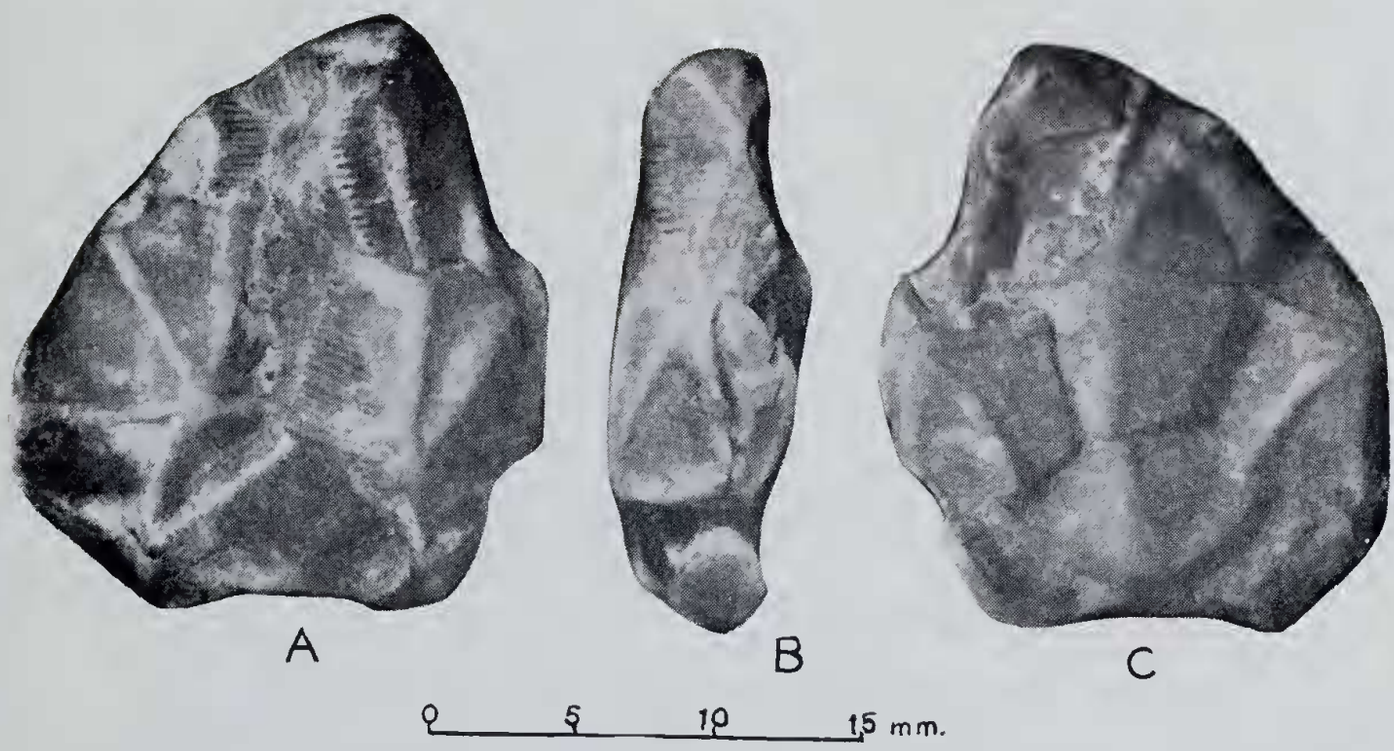

Fig. 3.—*Cheirocrinus merrileesi* sp. nov. Ordovician, Emanuel Formation, Emanuel Creek, Kimberley District, Western Australia. Holotype, Western Australian Museum, Perth, Western Australia Spec. No. 60.167. Photo I.A.B. A. Anterior, B. Left lateral and C. Posterior Views.

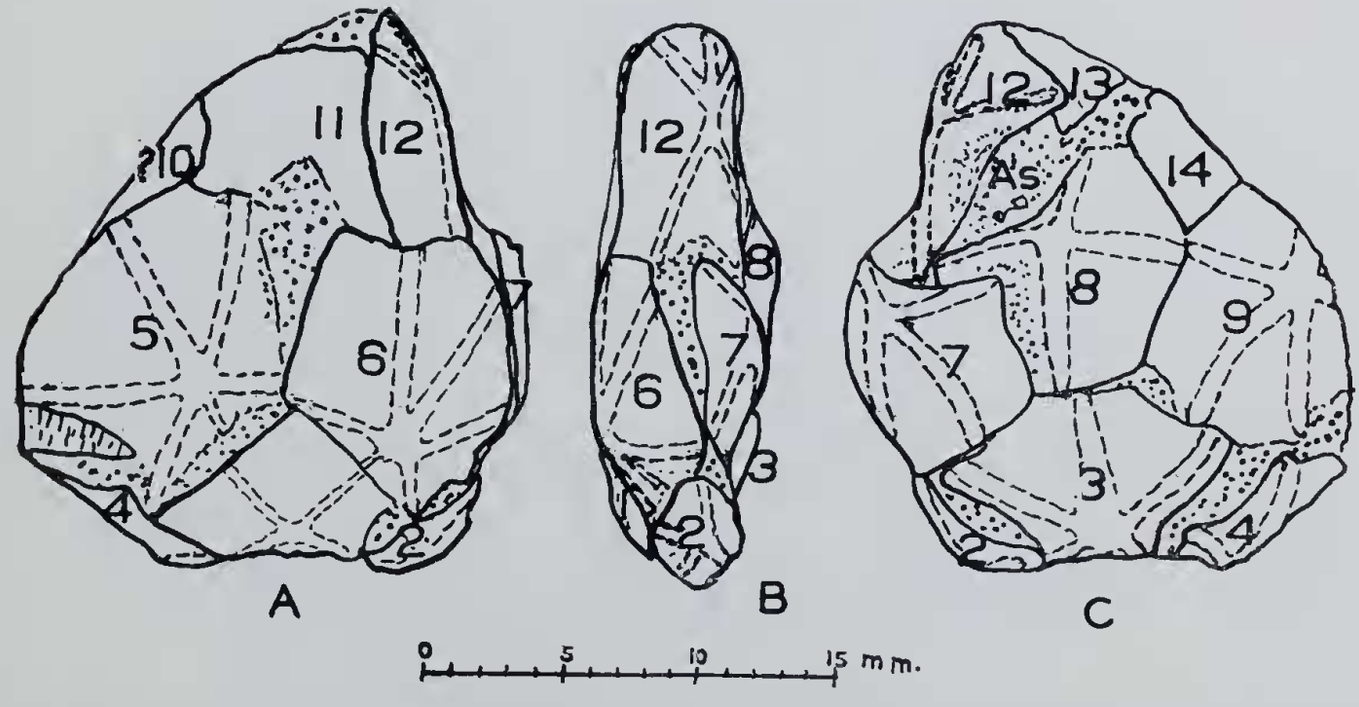

Fig. 4.—*Cheirocrinus merrileesi sp.* nov. Sketch of theca as shown in Fig. 3 to indicate identification of plates and position of radiating ridges.

thickness were rather greater than at present, since the plates have sprung apart along the sutures and some of the plates overlap, *e.g.* plates 1 and 6 overlap plate 5, and 7 overlaps part of 8. This displacement must have taken place during preservation, but except for plate 11, none of the individual plates appears to have suffered fracture or distortion.

Thus the complete theca was probably higher than wide, and considerably wider than thick, proportions which are characteristic of *Cheirocrinus* (Bather 1913, p. 435; Kirk 1911, p. 19).

The specimen is preserved in fine yellowish limestone, and the thecal plates are of crystalline calcite, the usual preservation of shells of fossil Echinodermata.

Each of the plates is thick, convex and has the well-marked radiating ridges characteristic of the genus, the centres of radiation usually being eccentric, as shown in the accompanying photograph (Fig. 3; A, B, and C) and corresponding diagram (Fig. 4; A, B, and C).

The positions of the ridges vary as indicated in Figures 3, 4 ,and 5. Sometimes they are normal to the middle of the sutures of adjacent plates and appear to have continued across the suture, *e.g.* from plates 3 to 7, 3 to 8, and 3 to 9: in plates 5 and 6 two of the ridges extend to the angles of the plates.

The analysis of the theca is shown in Figure 5.

No *column* is preserved but the scar for its insertion is clearly marked on the lower surface.

The *infra-basals*, plates 1 to 4, are variable in size; plates 2 and 4 are smallest; plate 1 is rhombohedral, modified at the lower edge for the insertion of the top of the column, while plate 3, the largest, is almost hexagonal, probably representing the fusion of two plates.

The *basals*, plates 5 to 9, are also variable in size; plates 5, 6 and 9 are hexagonal and plates 7 and 8 are modified for the anal area which is relatively large.

Of the lower *lateral plates* only plates 11, 12 and part of 14 remain. Plate 11 has been crushed inwards and its sutures with plates 5 and 6 are obscured. Plate 12 is folded about its vertical axis which is in the plane of compression of the theca, and its contact with the anal area is depressed. Only portion of plate 14, in contact with plates 8 and 9, is preserved. It was not considered advisable to remove more of the matrix on account of the risk of damage to the specimen.

No plates of the *fourth cycle*—plates 15 to 19—are preserved, but their existence must be presumed from the fact that the lower halves of pore-rhombs occur on plates 11 and 12, requiring plates 16, 17 and 18.

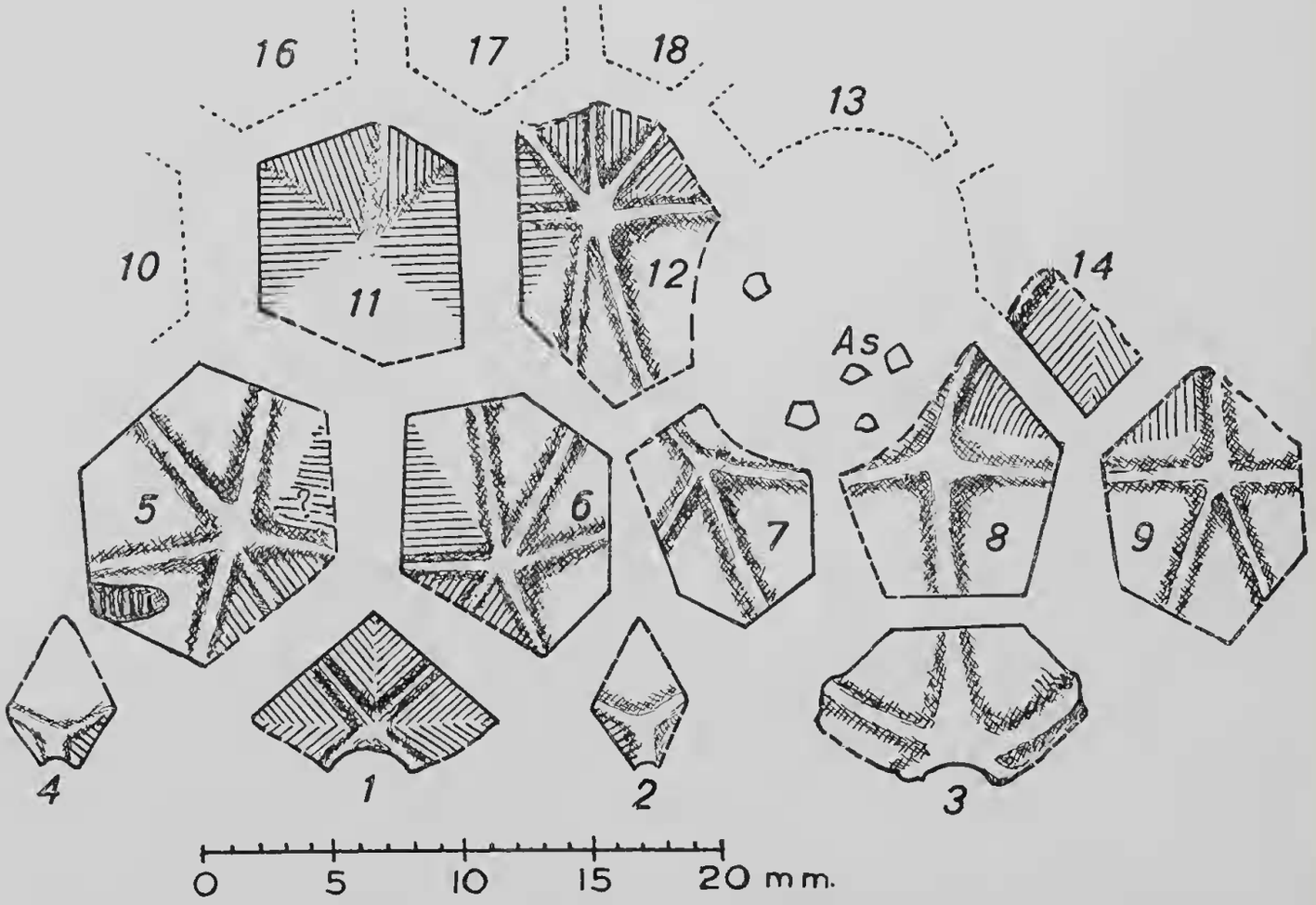

Fig. 5.—*Cheirocrinus merrileesi* sp. nov. Diagrammatic sketch to show structure and arrangement of the thecal plates, and the positions of the radiating ridges and pore-rhombs. Infra-basals 1-4, Basals 5-9, Lateral Plates 11, 12 and 14, Anal area, As.

There is a small water-worn piece of shelly material adhering to plate 5 which may be part of an ambulacral structure.

The arrangement of the pore-rhombs is shown in Figure 5. By comparison with Figure 2 it may be seen that it is in agreement with that of the Family Cheirocrinidae (Bather 1913). The pore-rhombs are all conjunct, the pore-slits passing uninterruptedly across the sutures. Rhombs 1/2 and 1/4 each have about 10 slits; 1/5 and 1/6 about 22 slits; rhomb 5/6 is abnormal in that the pore-slits, about 18 in number, form a triangular area on plate 6, such that the longest slit is not central, but at the end closest to plate 1; poor preservation prevents determination of all the pore-slits on plate 5.

A condition somewhat similar to that of plate 6 occurs on plates 8 and 9, where the longest slits are at one side, each against one of the radiating costae, but the slits pass directly across the sutures 8/14 and 9/14. Although plate 11 has been crushed inwards it bears its share of rhombs 11/?10, 11/?16, 11/?17 and 11/12.

A few scattered small plates indicate the anal area.

The remainder of the theca is lost.

Remarks.—Cheirocrinus merrileesi sp. nov. differs from all species of the related *Glyptocystites* in that plates 5 and 6 meet along a suture and are not separated by the upward extension of plate 1 to touch plate 11 (See Sinclair 1948, p. 310), and in this feature it differs also from *Cheirocrinus penniger* the type species of the genus (See Bather 1913, p. 436, Text-fig. 41).

Bather (1913) suggested a classification of the Cheirocrinidae based on the character of the rhombs, whether conjunct, disjunct or multidisjunct. *C. merrileesi* falls within his Group 1 ("Pectini-rhombs all, or at least on the base, conjunct".) in which he included only three species, *C. atavus* Jaekel, 1899, *C. giganteus* (Leuchtenberg, 1843) and *C. constrictus* Bather, 1913.

I have no specimens of described species of *Cheirocrinus* available for direct comparison, but to judge by the published descriptions and figures by Jaekel, Bather, Bassler, Sinclair and Regnell, the specimen from Western Australia differs from all other species in the arrangement of the plates and pore-rhombs, and therefore is regarded as a new species, which I have named *Cheirocrinus merrileesi* in honour of Mr. D. Merrilees.

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